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Thank you for your interest in our research and we look forward to receiving your feedback.

Yours sincerely,

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Aggregated wind power generation model

This comprises an introduction to running the model. The default wind farm distribution and power curve are set up for the GB power system. The resultant Capacity Factor time series is also included. In general, the wind farm distribution and power curve can be changed as necessary by the user by altering (or replacing) the input data (.dat) files.

Model Information

The model constructs an hourly time series of regional-total wind power over any specified time period since 1979, using MERRA reanalysis wind speed data. Written in Matlab, the model is run from the Master.m script, which builds a time series of regional total wind power generation from MERRA reanalysis data. It does so by calling other Matlab scripts to compute the required steps.

The model is designed so that all user-defined settings can be edited in Master.m, and the user need not edit the sub-scripts (MERRA_interp.m and MERRA_clim.m), which are called from Master.m. However, all scripts are well commented to help users understand and, if required, modify the model to their own needs.

Model inputs

- MERRA data containing wind speed data at 2m, 10m and 50m (see MERRA data section for details).

- Wind farm distribution and capacity data: windfarms.dat
  - A data file containing a list of wind farm locations (longitude/latitude), their capacity (in MW), and a farm-average turbine hub height above ground. See the example: windfarms.dat.
  - Store this file in the same directory as Master.m

- A wind farm power curve: A data file containing a list of wind speeds and corresponding power output (in fractional Capacity Factor: I.e., as a fraction of the total wind farm capacity). See the example powercurve.dat.
  - Store this file in the same directory as Master.m

Running the model

With these ingredients in place, the steps to build the time series are as follows:

1. Set the user-defined settings in Master.m
2. Run the Master.m script from an open Matlab session!

Model outputs

- If the interpolation step is computed, the model outputs MERRA wind speeds that have been horizontally interpolated to each of the wind farm locations in windfarms.dat (this wind speed data is stored in NETCDF format).

- The climatology step outputs:
  - A plot showing the power curve used.
  - A time series of hourly distribution-aggregated capacity factor (CF). [1]
  - A time series showing the date and time corresponding to each CF value.
  - Both the date/time and CF variables are saved to an ascii file (CF.dat), as well as to a Matlab data file (CF.mat).

[1] Capacity Factor = 100 % × [Total Power Generated (MW)] ÷ [Total Capacity (MW)].

Additional information

The model will loop through all days, months and years between the start and end dates specified in Master.m, extract the MERRA wind speed data and interpolate it to the desired wind farm locations using the MERRA_interp.m script. The power curve, wind farm capacity and turbine hub height data is then used to calculate the wind power output of the entire fleet in MERRA_clim.m.

Note, the MERRA_interp.m script can be slow when computing a long time series and/or a large distribution of wind farms. Therefore, the model stores the interpolated wind data so that any of the following inputs can be changed without the need to repeat the interpolation:

- Wind farm capacities
- Turbine hub heights
- Power curve

However, any change in the distribution (longitudes or latitudes) of the wind farm distribution will require the re-computation of the interpolated data. [2]

[2] A useful tip: If you want to use this model to study a number of different wind farm distributions, perform the interpolation step for all wind farm locations. Then, to test a particular distribution, just set the wind farm capacity to zero for any wind farms you do not wish to include. This will avoid having to re-compute the interpolation step for each distribution.

Some notes about the MERRA data

To use this model, you must have the raw MERRA data downloaded in advance. It can be downloaded from:

http://disc.sci.gsfc.nasa.gov/daac-bin/DataHoldings.pl [3]

The model is set up to read in the MERRA data product named "IAU 2d atmospheric single-level diagnostics (tavg1_2d_slv_Nx)", using the "Daily Data Product". This contains hourly wind speeds which are stored in a separate file for each day. Once downloaded, the MERRA files should look like this:

MERRANNN.prod.assim.tavg1_2d_slv_Nx.YYYYMMDD.SUB.nc

where NNN is an integer (this might be 100, 200, 300 or 301) and YYYYMMDD is the date of the file.

The model uses U and V wind components from 2m, 10m, and 50m ("U2M", "U10M", "U50M", "V2M", "V10M", "V50M"), which must be available in the MERRA data files.

The model assumes the data is stored in NETCDF format, and can be accessed at the location: pathname / year / filename, where:

- filename: the name of the raw MERRA NETCDF file
- year: a folder containing all raw MERRA NETCDF files for the year
- pathname: the directory where the "year" folders are stored

are all user-defined in the Master.m script.

[3] Website available as of 18 August 2014. If the link no longer works, try http://gmao.gsfc.nasa.gov/merra/ and navigate to the "Modeling and Assimilation Data and Information Services Center (MDISC)" page, and then find a link to "MERRA Data Products".